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(71) Applicant: AQUA HYDRAULICS LIMITED
Star Trading Estate Partridge Green
Horsham Sussex RH13 9RA(GB)

(72) Inventor: Leeson, Timothy Francis
"Two Hoots" Horsham Road Five Oaks
Billingshurst West Sussex RH14 9AR(GB)

(74) Representative: Long, Edward Anthony et al
Hulse & Co. Cavendish Buildings West Street
Sheffield S1 1ZZ(GB)

(54) Valve member and valve assembly for fluid flow control.

(57) A valve member comprises a generally cylindrical, hollow cage (2) of synthetic plastics material having an external periphery of curvature corresponding to that of a circular section bore (19) of a valve body (18) in which the cage (2) is adapted to be located, in use, as a readily displaceable, slide fit, with the cage (2) having an upstream end (3) adapted, in use, to be located adjacent a valve seat (21), and a downstream end (4); a circular, metallic valve head (12) carried coaxially by, and at, the upstream cage end (3), with a leading, annular sealing face (15) of the valve head (12), adapted, in use, to make sealing contact with an annular valve seat (21), and projecting beyond the upstream end of the cage, and being of smaller diameter than the cage, and a plurality of axially extending fingers (8), each having an arcuate periphery also of curvature corresponding to that of the bore (19), at least some of which fingers (8) are interconnected adjacent the upstream end (3) of the cage (2) by a transverse member (10) extending across the cage (2), with apertures (7) between adjacent fingers (8) to provide a fluid flow path, when the valve is open, from the valve seat (21) to the hollow interior (11) of the cage (2). The invention also includes a fluid flow control valve assembly (17) comprising a valve body (18) housing a valve member (1), a valve seat (24) provided by a portion of the valve body (18), and a coil compression spring (30) to urge the valve head (12) against the seat (24)

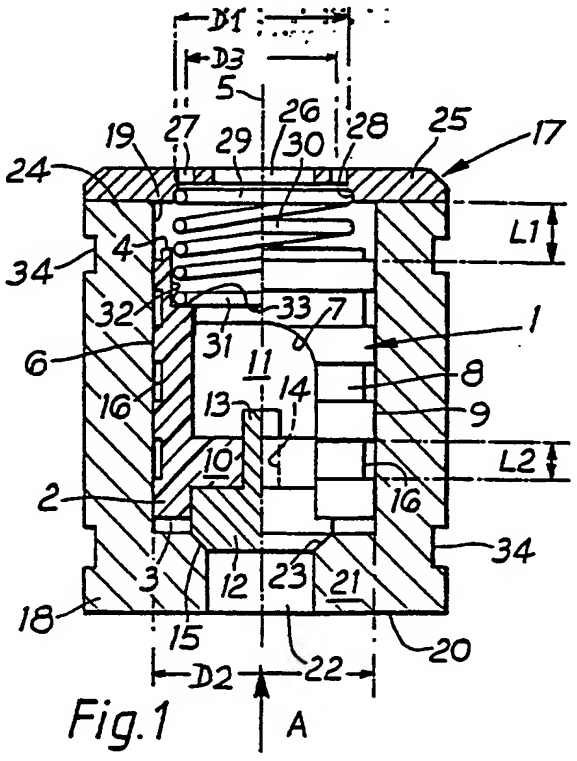

Fig.1

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VALVE MEMBER AND VALVE ASSEMBLY FOR FLUID FLOW CONTROL

This invention relates to a valve member and to a valve assembly incorporating such a valve member, for fluid flow control, suitable for example in a suction or outlet valve assembly of a positive displacement piston pump, or alternatively in a non-return valve assembly e.g., of a pipe line, with the valve head being spring-loaded into a closed position and linearly displaceable, under the action of fluid pressure, from its associated valve seat, with the maximum opening, or lift, being determined by a stop.

It is known in one valve assembly to provide the valve head with flutes serving for both centralising and guiding the valve with respect to a bore in a valve body, in which bore the valve head is slidably located, but such flutes restrict the fluid flow path through the valve throat e.g. by 40%, while furthermore, the guidance effect is reduced with valve lift. Of course, the alternative of external guidance may be employed, in which case the overlap, for valve member guidance, remains constant irrespective of the lift, but to obtain the length of flute necessary, there must be a considerable increase in the overall weight and hence cost of the valve head. This is particularly disadvantageous when a piston pump is involved, due to the high speed and frequency of operation, because the inertia effect of the valve mass damages both the valve seat and the stop.

Furthermore, with a valve assembly having a coil compression spring to load the valve head against a valve seat, both erosion and side loading can present serious problems if the fluid is forced between the spring coils, as well as restricting the spring design.

According to a first aspect of the present invention, there is provided a valve member comprising a generally cylindrical, hollow cage of synthetic plastics material having an external periphery of curvature corresponding to that of a circular section bore of a valve body in which the cage is adapted to be located, in use, as a readily displaceable, slide fit, with the cage having an upstream end adapted, in use, to be located adjacent a valve seat, and a downstream end; a circular, metallic valve head carried coaxially by and at the upstream cage end, with a leading, annular sealing face of the valve member, adapted, in use, to make sealing contact with an annular valve seat, projecting beyond the upstream end of the cage, and of smaller diameter than the cage, and a plurality of axially extending fingers, each having an arcuate periphery also of curvature corresponding to that of the bore, at least some of which fingers are interconnected adjacent the upstream end of the cage by a transverse member extending across the cage, with apertures between adjacent fingers to provide a fluid flow path, when the valve is open, from the valve seat to the hollow interior of the cage.

According to a second aspect of the present invention, there is also provided a fluid flow control valve assembly comprising a valve body housing a valve member as defined above, a valve seat provided by a portion of the valve body, and a coil compression spring to urge the valve head of the valve member against the valve seat.

The valve member in accordance with the first aspect of the invention provides a relatively lightweight guidance cage, of considerably reduced inertia compared with prior proposals and hence considerably reducing damage to the valve seat in a valve assembly of a piston pump for example, whilst the governing flow path is now the annular area exposed as the valve head lifts from its seat. The synthetic plastics material of the cage may be Delrin (Trade Mark) or similar. The metallic valve head is preferably hardened, and Monel is suitable, which combats erosion and wear on the annular sealing face of the valve head. Preferably, the cage incorporates three fingers, spaced 120° apart, in which case the transverse member would be constituted by a three spoked hub. This may be generally triangular, when viewed axially. The arrangement with three flutes provides three inlet apertures for fluid flow, when the valve head is lifted from its seat, along the valve throat, past the valve seat and into the hollow interior of the cage and, compared with prior art constructions of similarly dimensioned valve members, the valve member in accordance with the invention, particularly if exhibiting this last mentioned feature provides a substantially increased flow, and furthermore, a flow rate that is dependent upon the lift of the valve member.

It is also preferred for at least the guidance fingers, and possibly the entire cage, to be provided with circumferentially extending and axially spaced apart, balance grooves having an axial length e.g. of 5 mm, less than the valve lift, e.g. of 6 mm, the grooves providing the advantage that any debris, scale etc., that finds itself lodged between the external, circumferential periphery of a finger or the case and the valve bore will quickly be located in a groove, for ready conveyance to the hollow interior of the cage, thereby eliminating the long term presence of debris between a finger or the case and the valve bore, with the attendant potential for damage, such grooves additionally ensuring that wear does not result in steps in the valve bore.

Preferably, the transverse member, e.g. the spoked hub, also serves as a mounting for the valve head, by being provided with a through hole, coaxial with the longitudinal axis of the cage, whereby an integral spigot of the valve head may be a push-fit within the hole, the spigot preferably having a length greater than the valve lift.

An end portion of a coil compression spring of the valve assembly in accordance with the second aspect of the invention, may be located within the cage to bear on an annular flange located inwardly of the downstream end of the cage. Preferably, the spring diameter approximates to the cage diameter, so that at least the bulk of the fluid, upon entering the hollow cage interior via the apertures between the fingers, is directed along the centre of the spring, thus minimising, if not eliminating, side loading and erosion. This centre flow action is enhanced if in accordance with another preferred proposal, the internal diameter of the spring is equal to, or greater than, the internal diameter of the cage and inner faces of the fingers.

Preferably, the valve assembly comprises a cup-shaped metallic cartridge constituting the valve body, and providing the valve bore, of internal diameter approximating to the external diameter of the cage, in which bore the valve member in accordance with the first aspect is located, for reciprocable movement of its valve head into and out of engagement with the valve seat, the cartridge having a fluid inlet bore defining the valve throat diameter in an end wall, at an inner end of which bore the valve seat, which is preferably chamfered, is located. At the other end of the cartridge, a spring location plate is provided against which the other end of the coil spring is adapted to bear, the spring location plate having a circular locating recess for spring location purposes, and also having a fluid outlet aperture. Preferably, the spring location plate is also provided with at least one, and preferably three safety orifices to avoid the possibility of the location plate constituting a valve seat should debris (which could be in the water being pumped or could be a broken off part of the valve cage) find itself within the cartridge and tend to plug the fluid outlet aperture and damage associated equipment such as a pump. Externally, the cartridge may be provided with a pair of spaced-apart, circumferential grooves, each to accommodate a sealing ring.

The two aspects of the invention will now be described in greater detail, by way of example, with reference to the accompanying drawing, in which:-

Figure 1 is a part sectional side elevation of both the valve member in accordance with the first aspect, and the valve assembly in accordance with the second aspect; and

Figure 2 is a view in the direction of arrow A of a portion of Figure 1.

In the drawings, a valve member 1 in accordance with the first aspect of the invention comprises a generally cylindrical, hollow cage 2 of synthetic plastics material such as Delrin (Trade Mark) having an upstream end 3, a downstream end 4 and a longitudinal axis 5, and an arcuate periphery 6.

The cage 2 is provided with three inverted "U"-shaped cut-outs 7 located 120° apart to define three axially extending fingers 8 also 120° apart and having an arcuate periphery 9 inter-connected adjacent the upstream end 3 of the cage 2 by an integral transverse member 10 extending across the cage 2 and constituted as a three spoked hub with one spoke extending to each finger 8, as best seen in Figure 2 which is an end view of the cage 2 only. The cut-outs 7 provide fluid flow operatures between adjacent fingers 8 to the hollow interior 11 of the cage 2.

The valve member 1 is provided with a circular metallic valve head 12, e.g. of Monel (Trade Mark) co-axial with the cage 2 and at the upstream end 3 thereof, with an integral spigot 13 of the valve head 12 being a push-fit within a through hole 14 of the transverse member/spoked hub 10, while remote from the spigot 13, the valve head 12 is provided with a chamfered seating face 15.

Externally, the cage 2, including its fingers 7, is provided with circumferentially extending and axially spaced-apart balance grooves 16 having an axial length L2 less than the valve lift L1.

A fluid flow control valve assembly 17, in accordance with the second aspect of the invention comprises a valve member 1 housed within a cup-shaped metallic valve body 18 having an internal diameter of its circular section, cage receiving bore 19 approximating to the external diameter of the cage 2 such that the latter, in its capacity as a valve guide, is an easy sliding fit.

At an upstream or inlet end 20, the valve body 18 is provided with an end wall 21, a fluid inlet bore 22, defining the valve throat diameter, at an inner end of which bore 22 a chamfered valve seat 23 is located.

At the other downstream or outlet end 24 of the valve body 18 a spring location plate 25 is provided with a fluid outlet aperture 26 and two safety orifices 27 spaced 180° apart and is recessed at 28 to seat one end portion 29 of a coil compression spring 30, the other end portion 31 of which is housed in a counterbore 32 in the downstream end 4 of the cage 2 to bear on an annular radial flange 33 to urge the valve head 12 into seating engagement with the valve seat 23. The external periphery of the valve body 18 is circular so that the valve assembly 17 may be inserted, as a cartridge, into a

valve block/pump, with circumferential grooves 34 adjacent both ends to accommodate a sealing ring. The maximum valve lift is indicated by dimension "L1" in Figure 1, which dimension L1 is greater than the axial length L2 of the individual balance grooves 16 of the valve guide cage 2, while the spigot 13 also has a length greater than the valve lift.

Claims

1. A valve member comprising a generally cylindrical, hollow cage (2) of synthetic plastics material having an external periphery of curvature corresponding to that of a circular section bore (19) of a valve body (18) in which the cage (2) is adapted to be located, in use, as a readily displaceable, slide fit, with the cage (2) having an upstream end (3) adapted, in use, to be located adjacent a valve seat (21), and a downstream end (4); a circular, metallic valve head (12) carried coaxially by, and at, the upstream cage end (3), with a leading, annular sealing face (15) of the valve head (12), adapted, in use, to make sealing contact with an annular valve seat (21), and protecting beyond the upstream end of the cage, and being of smaller diameter than the cage, and a plurality of axially extending fingers (8), each having an arcuate periphery also of curvature corresponding to that of the bore (19), at least some of which fingers (8) are interconnected adjacent the upstream end (3) of the cage (2) by a transverse member (10) extending across the cage (2), with apertures (7) between adjacent fingers (8) to provide a fluid flow path, when the valve is open, from the valve seat (21) to the hollow interior (11) of the cage (2).

2. A valve member as claimed in Claim 1, wherein the cage (2) incorporates three fingers (8), spaced 120° apart, in which case the transverse member (10) is constituted by a three spoked hub.

3. A valve member as claimed in Claim 1 or Claim 2, wherein the fingers (8) are provided with circumferentially extending and axially spaced apart, balance grooves (16) having an axial length (L2) less than the valve lift (L1).

4. A valve member as claimed in any preceding Claim, wherein the entire cage (2) is provided with circumferentially extending and axially spaced apart, balance grooves (16) having an axial length (L2) less than the valve lift (L1).

5. A valve member as claimed in any preceding Claim, wherein the transverse member (10), e.g. the spoked hub, also serves as a mounting for the valve head (12), by being provided with a through hole (14), coaxial with the longitudinal axis (5) of the cage (2), whereby an integral spigot (13) of the valve head (12) is a push-fit within the hole (14.

6. A valve member as claimed in Claim 5, wherein the spigot (13) has a length greater than the valve lift (L1).

7. A fluid flow control valve assembly comprising a valve body (18) housing a valve member (1) as defined in any preceding Claim, a valve seat (24) provided by a portion of the valve body (18), and a coil compression spring (30) to urge the valve head (12) of the valve member (1) against the valve seat (24).

8. A valve assembly as claimed in Claim 7, wherein an end portion (29) of a coil compression spring (30) of the valve assembly (17) is located within a portion (27) of the cage (2) to bear on an annular flange (28) located inwardly of the downstream end (4) of the cage (2).

9. A valve assembly as claimed in Claim 7 or Claim 8, wherein the spring diameter (D1) approximates to the cage diameter (D2), so that at least the bulk of the fluid, upon entering the hollow interior (11) of the cage (2) via the apertures (7) between the fingers (8), is directed along the centre of the spring (30).

10. A valve assembly as claimed in any one of Claims 7 to 9, wherein the internal diameter (D3) of the spring (30) is equal to or greater than, the internal diameter (D4) of the cage (2) and the fingers (8).

11. A valve assembly as claimed in any one of Claims 7 to 10, comprising a cup-shaped metallic cartridge constituting the valve body (18), and providing the valve bore (19), of internal diameter approximating to the external diameter (D2) of the cage (2), in which bore (19) the valve member (1) is located, for reciprocable movement of its valve head (12) into and out of engagement with the valve seat (23), the cartridge having a fluid inlet bore (22) defining the valve throat diameter in an end wall (21), at an inner end of which bore the valve seat (23), which is preferably chamfered, is located.

12. A valve assembly as claimed in Claim 11, wherein at the other end of the cartridge, a spring location plate (25) is provided against which the other end (29) of the coil spring (30) is adapted to bear, the spring location plate (25) having a circular locating recess (28) for spring location purposes, and also having a fluid outlet aperture (26).

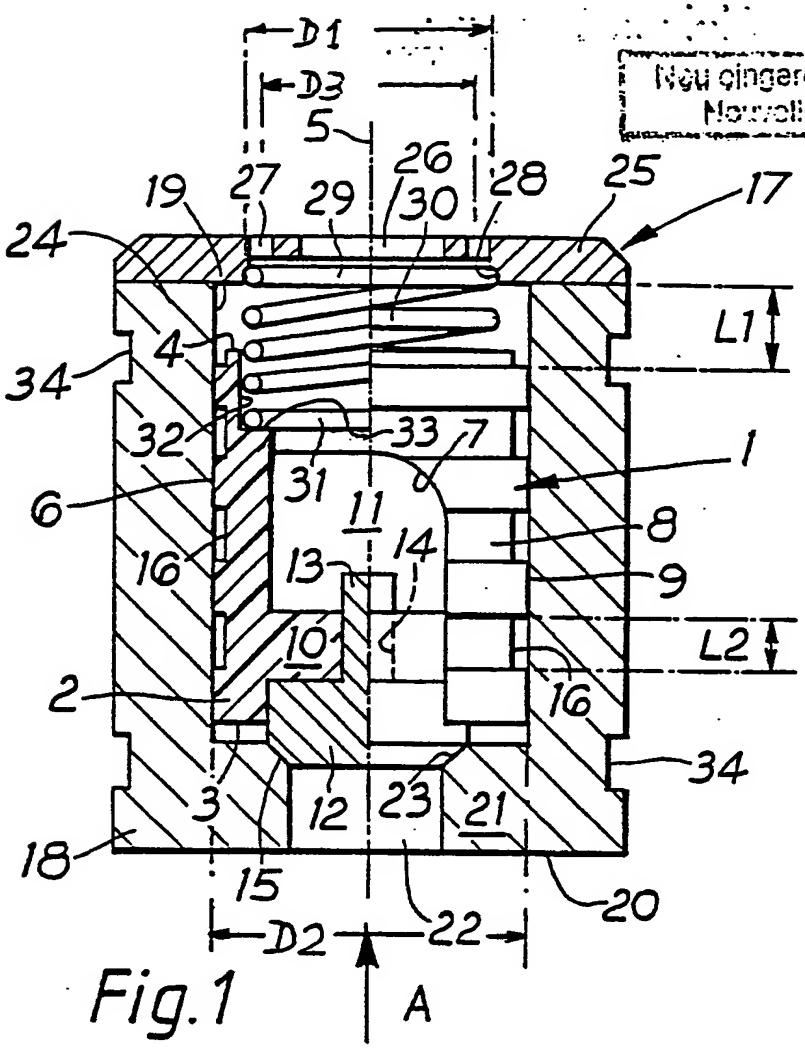

Fig. 1

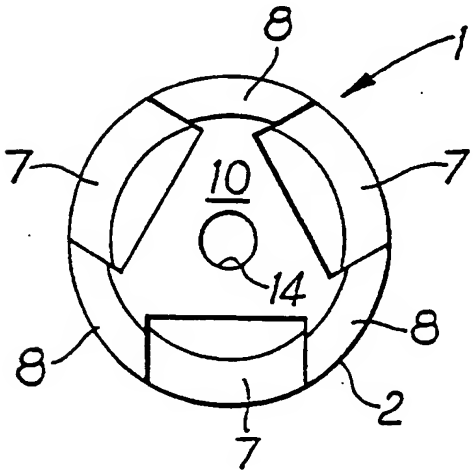

Fig. 2